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November 2019

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Prepared for the
U.S. Department of Energy

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All opinions, errors, and omissions remain the responsibility of the authors. All reference URLs were accurate as of the date of publication.

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Acronyms and Abbreviations

APPA	American Public Power Association
Berkeley Lab	Lawrence Berkeley National Laboratory
C&I	Commercial, industrial and agricultural
CEE	Consortium for Energy Efficiency
CSE	Cost of saving electricity
DOE	U.S. Department of Energy
EIA	U.S. Energy Information Administration
EM&V	Evaluation, measurement and verification
GWh	Gigawatt-hour
HVAC	Heating, ventilation and air conditioning
IOU	Investor-owned utility
kWh	Kilowatt-hour
LBNL	Lawrence Berkeley National Laboratory
PA	Program administrator
PA CSE	Levelized program administrator cost of saving electricity
POU	Publicly owned utility
QA	Quality assurance

Executive Summary

Cost-effective energy efficiency programs are an important tool that electric utilities use to provide reliable service at the most affordable cost. Accurate assessments of the cost performance of these programs are an increasing priority with declining costs for some supply-side resource alternatives, such as wind, solar, and natural gas.

Expressed in dollars per kilowatt-hour (kWh) of electricity savings, the *program administrator cost of saving electricity* (PA CSE) measures costs from the perspective of utilities and other program administrators. Utilities rely on this metric to:

- Compare relative costs of various types of efficiency programs.
- Compare efficiency options to other demand and supply choices for serving electricity needs as they plan investments to meet reliability and other requirements at a reasonable cost, and then procure resources consistent with that plan.

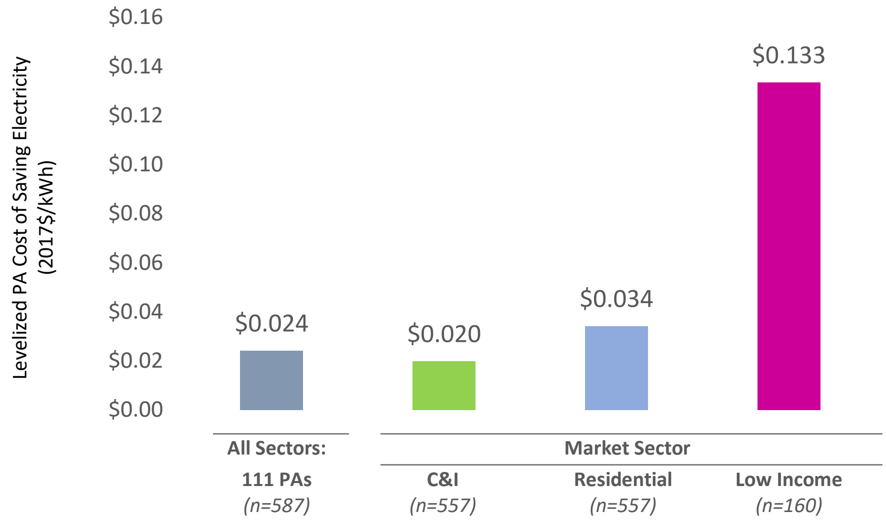
Lawrence Berkeley National Laboratory (Berkeley Lab) collects and analyzes program data nationwide to help utilities and state, local, and regional decision makers assess cost performance. A series of studies by Berkeley Lab provides detailed data and analysis on the cost of saving electricity for investor-owned utilities (IOUs) as it changes over time. While we have partnered with the American Public Power Association (APPA) to develop an efficiency program reporting tool for member utilities, this is the first time we focused this type of analysis on publicly owned utilities (POUs). These utilities have a fundamentally different economic structure than IOUs, and generally a locally elected or appointed governing board oversees electricity efficiency programs, rather than the state public utility commission. Other differences, such as size and diversity of markets and scale at which they can operate, affect program opportunities and costs.

In this study, Berkeley Lab collected and analyzed electricity efficiency program spending and savings data from 2012 to 2017 for 111 program administrators, covering 219 POUs in 14 states—about 90 percent of the municipal utilities and public utility districts that report efficiency program data to the U.S. Energy Information Administration (EIA). Our dataset represents 88 percent of all POU spending and 75 percent of all POU savings reported during the period. This report summarizes the levelized PA CSE for POUs in our dataset, using data POUs or their program administrators reported. The savings-weighted average PA CSE for all program administrators in our dataset for the study period is $0.024/kWh.

Figure ES-1 shows that the PA CSE varies widely by market sector, with the lowest cost savings in the commercial and industrial (C&I) sector at $0.020/kWh. The PA CSE for POU residential programs is much higher at $0.034/kWh.[1] This finding differs from our studies of IOU programs, where the residential sector is the least-cost source of electricity savings (Hoffman et al. 2018).

[1] As Figure ES-1 shows, the PA CSE for POU low-income programs, a separate category in our dataset, is $0.133/kWh.

Figure ES-1. Levelized savings-weighted PA CSE for efficiency programs as reported by 111 POU program administrators: 2012–2017[2,3]



PA – program administrator; CSE – cost of saving electricity; kWh – kilowatt-hour; C&I – commercial and industrial; n – sample size

The cost of saving electricity for POUs varies by geographic regions, as evident in Figure ES-2. The PA CSE values for C&I are relatively low in all regions. Inconsistent reporting on low-income programs by POUs—e.g., reporting these programs as a separate category or combined with other residential programs—influences the wide variation in low-income program costs.

The PA CSE for our dataset remained fairly constant from year to year over our study period, declining slightly (-0.7 percent) even as the overall level of savings increased from 1.1 percent of retail sales in 2012 to 1.3 percent in 2017. Nearly 60 percent of reported POU savings in our database comes from the C&I sector. Continued focus on this sector may help maintain low overall costs for POU efficiency programs and their continued viability for addressing load growth and maintaining affordable electricity costs for consumers.

Our findings are not a definitive measure of POU efficiency program cost performance. First, while representing the vast majority of spending and savings that POUs report to EIA, this initial Berkeley Lab study on the cost of saving electricity for POUs draws from 14 states (as compared to 41 states for our most recent IOU study). Second, our data and savings are unevenly distributed, with the larger utilities in the West and South heavily influencing the savings-weighted PA CSE values. The PA CSE also is dependent on the savings and cost data as reported by POUs.

[2] The sample size for our full dataset is not the sum of market sector values. This initial study on POUs does not report program-level results.

[3] The full sample of 111 PAs includes those with programs for which the utilities are not claiming savings, but that support program planning, research, evaluation, and measurement.

Figure ES-2. Savings-weighted PA CSE by market sector and U.S. Census region for 111 POU program administrators: 2012–2017

PA – program administrator; CSE – cost of saving electricity; kWh – kilowatt-hour; C&I – commercial and industrial

Our POU data collection includes commendable examples of program reporting, as well as opportunities for improvements that would increase confidence in utility load forecasts and planning electricity system investments. Among potential future areas of research are strengthening regional analyses with data from additional POUs, assessing cost performance for the most prevalent types of POU programs, and analyzing the total cost of saving electricity (including participant costs).

1. Introduction

Utilities rely on the program administrator cost of saving electricity (PA CSE) for several purposes: to assess potential effectiveness of efficiency program portfolios, determine what programs to offer customers, compare efficiency options to other demand and supply choices for serving electricity needs as utilities plan investments to meet reliability and other requirements at a reasonable cost, and procure resources consistent with that plan.[4] Accurate assessments of the cost performance of electricity efficiency programs are an increasingly important priority with declining costs for some supply-side resource alternatives, such as wind, solar, and natural gas.

Berkeley Lab collects and analyzes efficiency program data on a national scale to help utilities and state, local, and regional decision makers assess cost performance across geographic regions, states, and market sectors and for specific types of programs. In previous studies, we quantified the levelized PA CSE for electricity (and the cost of saving natural gas) for the period 2009 to 2011 (Billingsley et al. 2014); the PA CSE and total cost of saving electricity—including participant costs—from 2009 to 2013 (Hoffman et al. 2015); trends in the PA CSE during this same period (Hoffman et al. 2017); and multiple performance metrics and trends covering 41 states from 2009 to 2015 (Hoffman et al. 2018).[5]

All these prior analyses focused on programs funded by customers of investor-owned utilities (IOUs). For this study, we turn for the first time to programs funded by customers of publicly owned utilities (POUs). POUs primarily are municipal utilities but also include public utility districts and certain other public entities. POUs account for 60 percent of all U.S. electric utilities.[6]

In 2017 POUs served about 15 percent of U.S. electricity customers and 16 percent of electric load served by utilities. POU program administrators reported annual efficiency program savings in 2017 that, using a *simple average*, represent 0.7 percent of POU reported sales. However, POU program administrators, *on a weighted average basis,* reported annual savings in 2017 amounting to 1 percent of POU reported retail sales, reflecting somewhat higher savings acquisition among the largest POU program administrators (EIA 2013–2018).

Expanding our data collection and analysis to POUs provides insight into ways their efficiency initiatives vary among market sectors and geographic regions, as well as factors that differentiate the cost performance of these programs from programs funded by IOU customers—and where commonalities exist. Both POUs and IOUs offer largely similar kinds of efficiency programs. However, POUs have a

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[4] See Berkeley Lab (2016), *The Future of Electricity Resource Planning*, https://emp.lbl.gov/publications/future-electricity-resource-planning, and additional information at https://emp.lbl.gov/projects/utility-resource-planning.
[5] We also develop tools and methods (e.g., program typology, standardized definitions for program data) that facilitate greater rigor, comprehensiveness and transparency in program reporting (https://emp.lbl.gov/projects/what-it-costs-save-energy), including a tool developed with APPA specifically for publicly owned utilities (https://emp.lbl.gov/publications/energy-efficiency-reporting-tool).
[6] APPA. 2019. Stats and Facts. https://www.publicpower.org/public-power/stats-and-facts.

fundamentally different economic structure, and state public utility commissions generally do not oversee their programs. Other differences include some of the drivers for POU programs, the size and diversity of their markets, the scale at which they can operate (Kushler et al. 2015; Ribeiro et al. 2015, 2017), reporting requirements, and financing options for energy efficiency activities. All of these factors may affect program ambitions, opportunities, and costs. POUs also may have more control over other sources of end-use electricity savings such as building energy code adoption, inspection, and enforcement; municipal buildings and other public structures; and street lighting.

1.1 Cost of Saving Electricity as a Metric

The PA CSE is a measure of the cost performance of electricity-saving activities from the economic perspective of the utility. In simplest terms, this metric is the cost of activities that avoid the use—and therefore the production and delivery—of a kilowatt-hour. The PA CSE spreads, or "levelizes," those efficiency costs over the working life of the electricity-saving measures and activities. Researchers devised this metric to size up efficiency investment costs against the cost of building and operating a power plant (e.g., Sant 1979; Meier 1982, 1984). Conceptually, efficiency measure or program costs are treated as investments financed with a loan, with a repayment term equal to the life of the measure.[7]

Resource planners and grid operators rely on the PA CSE for assessing prospects for future energy savings and projecting the impact of energy efficiency on load forecasts.[8] Utilities also use the PA CSE to determine what efficiency resources are the likeliest candidates for consideration in an integrated resource plan and for planning and designing efficiency programs and portfolios. In addition, benchmarking program performance against regional and national estimates of the PA CSE can reveal opportunities for improvements, especially when costs can be disaggregated (e.g., administration, marketing costs, incentives to customers).[9] Assessing how the cost of saving electricity changes with savings levels and participation can indicate whether a program or portfolio of programs has potential to scale up in savings. Assessing trends in PA CSE over time helps utilities and states weigh strategies and consider the role of energy efficiency in meeting their energy goals.

Cost-Effectiveness Screening vs. the Cost of Saving Electricity

The Utility Cost Test, the Total Resource Cost Test, and the Societal Cost Test are the primary screening tools for comparing the costs and benefits of energy efficiency programs and informing decisions about whether utility customers should fund a program (NESP 2017). The **program administrator cost of saving electricity** is not intended to define and capture all the benefits and costs of energy efficiency. The metric answers a simple question: *What is the cost to the utility or other program administrator to save a kilowatt-hour?*

[7] For a more detailed account of the evolution of this metric, see Hoffman et al. 2018.
[8] For example, the independent system operator for New England calculates a cost of saving electricity for each program administrator in its territory and uses those values, with adjustments, to translate future efficiency program budgets into savings projections that can be used to refine its load forecast.
[9] Examining the relative performance of spending on marketing and outreach versus incentives could indicate where the next dollar is best spent, for example.

We use the *savings-weighted average* cost of saving electricity for our studies, assigning the cost performance of each program administrator more or less value based on annual electricity savings. That means programs with higher savings have greater influence on the average cost of saving electricity than programs with lower savings.

1.2 Report Objectives and Roadmap

This study is by far the most expansive effort to date to quantify the levelized cost of electricity savings for efficiency programs funded by POU utility customers.[10] We assess the cost of saving electricity for efficiency programs funded by customers of POUs, as reported by the POUs, and the associated data. Specifically, this report addresses the PA CSE at the market sector level—commercial and industrial (C&I), residential, and low income—and answers several fundamental questions:

- What is the cost of saving electricity for POUs for recent years—nationwide and by region?
- How is the cost changing over time?
- What is the current state of POU program reporting and data?

The remainder of this report is organized as follows:

- *Chapter 2* describes our approach to data collection and analysis. We describe the data, extent of data coverage, data standardization, and analytical challenges. We also provide an overview of sector-level program spending and annual and lifetime savings.
- *Chapter 3* presents spending and savings data we collected for this study.
- *Chapter 4* presents the average PA CSE by region and market sector, as well as median PA CSE, and ranges by market sector to illustrate the spread of reported values. We examine trends in the program administrator cost of savings between 2012 and 2017.
- *Chapter 5* summarizes key findings and implications of this work, including potential benefits of improvements in completeness, accuracy, and rigor in program evaluation and reporting.
- *Appendix A* summarizes POU program administrators in our dataset for this study. *Appendix B* describes our program typology.

[10] Molina and Relf (2018) assessed the cost of saving electricity for the 49 largest U.S. utilities for program year 2015, including four POUs. Baatz et al. (2016) examined the PA CSE for 14 efficiency program administrators with large-scale savings, including two POUs.

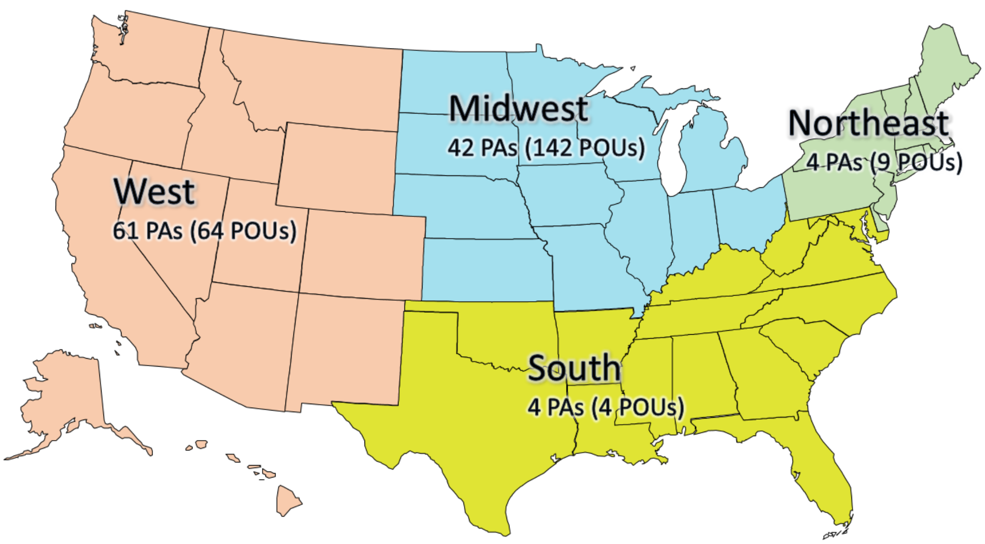
2. Data Collection and Analysis Approach

This chapter summarizes our efforts to obtain, standardize, and synthesize reported data on costs and savings for electricity efficiency programs funded by POU customers. We also discuss our challenges associated with collecting and translating these data into an indicator of efficiency cost performance that is applicable across the localized nature of POU markets and reporting. Our data challenges were in some cases more substantial than collecting and analyzing data from IOU customer-funded programs. For example, because most POUs do not report on their programs at a centralized (e.g., state) level, data require more time for research staff to acquire. Also, POU efficiency programs may be administered by a small staff, who may be dividing their time among other constituent services. Even so, when we approached POUs for this study, we typically found a willingness to share data necessary for our analyses.

2.1 Overview of Data Collection

Researchers at Berkeley Lab collected data from 111 efficiency program administrators that operate programs funded by customers of 219 POUs in 14 states. The collection includes data in all four U.S. Census regions (Figure 2-1). Most POUs covered by our data are municipal utilities, but many—including several of the largest POUs in the collection—are public utility districts, irrigation districts, and other political subdivisions whose territories often extend beyond a single municipality (Appendix A).[11]

Figure 2-1. POUs and other public power efficiency program administrators in our sample



POUs – Publicly owned utilities

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[11] "**Municipal (M)**: Entities that are organized under authority of state statute to provide a public service to residents of that area. **Political Subdivision (P)** (also called 'public utility district'): Independent of city or county government and voted into existence by a majority of the residents of any given area for the specific purpose of providing utility service to the voters. State laws provide for the formation of such districts."
https://www.eia.gov/survey/form/eia_861/instructions.pdf

The number of POUs whose customers are funding the programs in our database (219) exceeds the number of entities administering the programs (111) because some entities administer programs for multiple utilities. Entities such as municipal associations, public power districts, bulk power suppliers for municipal utilities, joint action agencies, and municipal aggregators often administer programs and report program spending and savings on behalf of multiple POUs. One entity, for example, administers programs for more than 50 utilities. Thus, the collected data cover programs funded by customers of 219 POUs for at least a year of our study period. These utilities account for about 6 percent of all U.S. utility retail electricity sales and nearly 40 percent of retail sales by POUs (EIA 2013–2018).[12]

Berkeley Lab obtained POU program data through multiple sources:

- Utilities responding to American Public Power Association's (APPA's) request to provide data
- Annual reports posted on a website for the utility or other program administrator
- A data collection for a subset of mostly large POUs in the mid-2010s, gathered as part of an unpublished benchmarking effort among members of the Large Public Power Council[13]
- Annual reporting to a state utility commission or energy office
- Regional data collections for multiple program administrators[14]
- Direct solicitations by Berkeley Lab

In many cases, Berkeley Lab acquired data for a program administrator from multiple sources—e.g., posted annual reports augmented by data provided by utility staff or a state public power association. Several program administrators, municipal aggregators, and states provided us with reports that were not publicly posted or filled gaps in what was available.

Berkeley Lab considered several factors in prioritizing collection of program data:

- Geographic diversity
- Likelihood of acquiring complete data (savings and full program spending) and, secondarily, reporting of program- or sector-level measure lifetimes to increase the sample from which the number of years for levelizing costs could be drawn
- Data for large POUs with diverse markets, mostly retail sales[15] and generally robust reporting, in order to use these utilities' large volumes of savings and related costs in our analyses
- Bolstering the database with smaller POU program administrators, as indicated by retail electricity sales and efficiency program spending, to better reflect program diversity
- Obtaining data sources with reporting by large numbers of program administrators

[12] POUs serve about 16 percent of electricity load in the United States. Retail sales here are defined as bundled sales.

[13] The association includes 27 large, fully integrated utilities and wholesale suppliers to municipal and cooperative utilities. See https://www.lppc.org/who-we-are/our-members.

[14] For efficiency program data in the Pacific Northwest, for example, Berkeley Lab relied on a public data collection assembled and maintained by the Northwest Power and Conservation Council. The Council reports annually on the region's energy efficiency efforts and achievements.

[15] We did not collect efficiency program data for POUs selling primarily to governmental entities, utilities or other wholesale customers.

We also applied decision rules for data collection and analysis:

- We did not collect data for program administrators serving a large and inseparable share of non-POU customers (e.g., wholesale accounts or customers of rural cooperatives).[16]
- We excluded from the analysis data for which only partial program costs were available (e.g., incentive costs but not administrative costs). Some data that included savings but no costs, or only incentive costs, were collected but deemed inadequate for inclusion in a PA CSE calculation meant to reflect the full program costs of efficiency.

One area in which costs may not be fully reported is administrative staff time. In many cases, POU staff devoted time to non-efficiency-related duties or were paid from non-efficiency program accounts, or both.[17] In these cases, the program administrator did not allocate internal labor or overhead costs to energy efficiency programs or the entire portfolio. When identified, we decided against including these data in our PA CSE analyses, to avoid understating program costs.

Program, Sector and Portfolio Years

About two-thirds of the data Berkeley Lab collected for this study are at the program level. **Program years** represent spending and savings data for a *single program* for a single year. For example, data covering four years of spending and savings for a particular program represent four program years. One-third of the data were available only at the market sector level.

We rolled up all program year data to the market sector level for each program administrator to create **sector years**—the administrator's total spending and savings data for *all programs* targeting a market sector for a specific year. We then aggregated the sector years by region and for the full dataset.

Sample sizes (n) in charts and tables are in **portfolio years** for results for the full dataset or all data for a region. Sample sizes are in sector years for results by market sector.

Ultimately, our POU data collection added about 2,600 program years (and 1,100 sector years) to the Berkeley Lab cost of saving electricity database, which now includes more than 13,000 program years of data (see text box). Because of limited data availability and resources for our first-time analysis of the PA CSE for POUs, we rolled up program level data to the market sector level and estimated PA CSE at the market sector and portfolio levels. Coincidentally, aggregating program-level data at the sector level yielded the same number of sector years for residential and C&I—557 sector years each for the 2012–2017 period.

Data fields for each program or sector year include the program name, spending (e.g., budget, expenditures, cost breakdown) and annual gross savings. Fields also may include lifetime savings, net savings, average measure lifetimes, and number of participants, projects, or units.

[16] For example, we did not include community choice aggregators because most include substantial load and funding from municipalities and other entities that are not utilities.
[17] Administrative time, when included, may be allocated in a manner that does not reflect actual time spent on an individual program or programs for a particular market sector. That may result in under- or over-estimating costs. This is a common issue across all types of programs offered by all types of utilities.

Despite our efforts toward a geographically diverse dataset, the number of POUs, data, and magnitude of savings and spending are unevenly distributed by state and region. Our dataset includes 142 POUs in the Midwest, 64 in the West, nine in the Northeast, and four in the South. These differences affect the level of confidence in our regional results for the South and Northeast since program administrator sample sizes in these two regions are relatively small. Figure 2-2 illustrates the distribution of program spending and savings by U.S. Census region for the 111 POU program administrators in our sample.

Figure 2-2. Regional distribution of program spending and annual savings for 111 POU program administrators

POUs – Publicly owned utility

While regional distribution of program spending provides an indication of data coverage, distribution of savings is more important because the PA CSE values at each level of analysis are savings-weighted averages. The West accounts for the largest share of savings in the dataset (72 percent) and has the largest influence over the national portfolio and market sector PA CSE values provided in this report for the 14 states. The results also are skewed toward generally larger POU program administrators because we use savings-weighted averages (see Section 1.1).

While the final dataset does not represent reporting by all POUs, it reflects the vast majority of national spending and savings (see Section 2.2) and significant diversity in size of POU program administrators. The median-size POU in the data collection has about 10,000 customers, with the smallest POU serving 136 customers and the largest serving more than 1.4 million (EIA 2013–2018). Most POU program administrators in this analysis serve urban and suburban areas. Yet a number started as agricultural irrigation projects that attracted development and now power cities. Others started as urban power districts that expanded into rural areas, which they may serve with agricultural energy efficiency programs.

2.2 Spending and Savings: Berkeley Lab Dataset vs. Nationally Reported Data

The 219 POUs covered by our dataset represent about 90 percent of the municipal utilities and public utility districts that report efficiency program data to the EIA. Further, our POU efficiency spending and savings data account for 88 percent of all POU spending on these programs and 75 percent of all POU savings, as reported to EIA, for our study period.[18]

Table 2-1 shows the annual values.[19] We report *incremental annual savings*—those acquired as a result of efficiency activities in the program year—for the full year, regardless of the month measures were installed. Most savings data are reported as claimed values.[20]

Table 2-1. POU efficiency program spending and savings: Berkeley Lab dataset compared to total reported U.S. POU values: 2012–2017

Year	Total Annual POU Efficiency Spending in LBNL Dataset (nominal $M)	Total Annual POU Efficiency Spending Reported in EIA-861 Annual Surveys (nominal $M)	POU Program Spending in LBNL Dataset as a % of Reported U.S. POU Program Spending (%)	Total Annual POU Savings in LBNL Dataset (GWh)	Total Annual Savings Reported in EIA-861 Annual Surveys (GWh)	Program Savings as a Percent of Total Reported U.S. Program Savings (%)
2012	333.7	392.50	85	1,859	2,244	83
2013	380.4	431.00	88	2,212	2,401	92
2014	389.8	466.70	84	2,142	2,590	83
2015	372.3	418.50	89	1,567	2,576	61
2016	354.1	397.00	89	1,558	2,586	60
2017	444.7	467.90	95	1,991	2,743	73
Totals and Averages	**2,275.0**	**2,573.60**	**88**	**11,329**	**15,141**	**75**

POUs – Publicly owned utility; M – millions; GWh – gigawatt-hour; EIA – Energy Information Administration

[18] Information reported on forms EIA-861 and EIA 861-S. For context, data on POU electricity efficiency program *spending* used in this analysis accounted for about 7 percent of total electricity efficiency spending reported to EIA for all programs funded by customers of all types of electric utilities. Annual electricity *savings* from programs in our POU dataset accounted for about 7 percent of all electricity savings reported, based on EIA survey data (EIA 2013–2018).
[19] The underlying data reported to EIA and analyzed by Berkeley Lab are not complete for all years. In addition, program reporting with full cost accounting was not available for all program administrators for all years in either dataset.
[20] *Claimed savings* are typically calculated by multiplying the number of efficiency measures installed (or actions taken) by *ex ante* estimates of the per-unit savings. These *ex ante* estimates are often documented in a technical reference manual of efficiency measures and actions. *Ex ante* estimates are derived using various methods, including building energy simulation models, deemed calculation methods, and deemed savings approaches. Most program administrators also typically have an independent evaluator undertake *ex post* verification that a sample of measures have been installed and are operating properly. Program administrators also may conduct *ex post* impact evaluations to verify installation or implementation of efficiency actions and use various methods to estimate the actual amount of savings acquired.

2.3 Cost of Saving Electricity: Definition and Inputs

The levelized PA CSE is the cost of achieving electricity savings over the economic lifetime of the actions taken as a result of a program, or a set of programs, amortized over that lifetime and discounted back to the year in which costs are paid. The PA CSE accounts for spending on planning, administering, designing, and implementing programs and providing incentives to market allies and end users to take actions that result in electricity savings, as well as costs of verifying savings.[21] The following equation shows the calculation for the PA CSE.

Program Administrator Cost of Saving Electricity =

$$\frac{\textit{Capital Recovery Factor * (Program Administrator Costs)}}{\textit{Annual Electricity Savings (in kWh)}}$$

where the Capital Recovery Factor (CRF) is

$$CRF = \frac{r(1+r)^N}{(1+r)^N - 1}.$$

and

r = the discount rate

N = estimated program lifetime in years and calculated as the savings-weighted lifetime of measures or actions installed by participating customers in a program.

We use a 4 percent real discount rate as an approximation of the cost of capital for a utility.[22]

We use *gross savings* in calculating PA CSE primarily because net savings are not universally reported or uniformly defined. Inconsistencies in defining and estimating net savings (and to a lesser degree, gross

[21] We included evaluation, measurement, and verification (EM&V) costs at the portfolio-level and for specific programs (if reported at the program level). Some ancillary costs associated with investments in energy efficiency are not included because they are not reported, are not included in program administrator annual reports, or are not included in the standard definition of the PA CSE, such as state or federal tax credits.

[22] We use a real discount rate because inflation already is accounted for in our use of constant dollars (2017$). We arrived at the discount rate by estimating the cost of capital to POUs based on the long-term average prices for municipal bonds. From this average, we subtracted 1.6 percent inflation. The Northwest Power and Conservation Council used this approach in its estimation of POU discount rates as a precursor to calculating a composite discount rate for the Seventh Northwest Conservation and Electric Power Plan—specifically, for modeling energy resource costs among all decision makers in the Council's footprint. See Appendix A of the Seventh Plan: Financial Assumptions and Discount Rate, https://www.nwcouncil.org/sites/default/files/7thplanfinal_appdixa_financassum_1.pdf. Technically, program participants invest in efficiency using their own discount rate, which is generally higher than a utility cost of capital. Some analysts take this difference in discount rates into account when calculating a *total* cost of saving electricity that includes the participant share of measure costs. Besides adding complexity, that hybrid approach is not applicable in calculating the PA CSE, which is based solely on the costs and discounting of the POU or its program administrator.

savings) adds considerably to the uncertainties already embedded in estimates of energy savings.[23]

The savings data in our dataset are primarily *claimed savings*, taken from reports, tracking spreadsheets, or other documents supplied by POU program administrators.[24] These data are not verified by Berkeley Lab researchers. Thus, our data sources are all secondary.

Another critical value in the PA CSE is the lifetime of the energy-saving measures or activities. The calculation spreads the costs of a program over the average measure lifetime for the program. To develop those values at the market-sector level, we calculated lifetime savings for each program in each sector using information on measure lifetimes provided by the POU program administrator. A few administrators reported measure lifetimes that are significantly longer than are traditionally assumed—e.g., 45 years for residential insulation and 50 years for commercial air conditioning units. In these cases, we imposed a cap on the assumed lifetime at 30 years.[25]

Key Definitions

Gross Annual Incremental Savings: Savings acquired or planned to be acquired as a result of energy efficiency activities in that program year. These are annualized, "full-year" savings, regardless of when measures were installed during the program year. Gross savings are the difference in energy consumption with the energy efficiency measures promoted by the program in place versus what consumption would have been without those measures in place.

Program Administrator Costs: Actual spending by the program administrator on planning, designing, and implementing an energy efficiency program in a defined geographic area, as well as incentives paid to any party; marketing, education, and outreach; other overhead; and, where available, evaluation, measurement, and verification activities.

If no information on savings lifetime was available, we took the average of the reported and calculated measure lifetimes for each program type and imputed those values to the programs of that type that lacked a defined measure life. We also imputed measure lifetimes at the market-sector level when not reported. To develop these values, we divided reported or calculated lifetime savings for all programs in that market sector by the annual savings for those programs. This method produced a savings-weighted sector average measure life for the sector-level imputations for use in levelizing reported sector costs (see Table 2-2). Variations in assumptions with respect to how these measure life values are calculated adds to potentially significant differences in PA CSE values.

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23 Distinctions between so-called "net" and "gross" savings are important elements of analysis of impacts of efficiency programs (SEE Action Network 2012). Gross savings are defined as the difference in energy consumption with the energy efficiency measures promoted by the program in place versus what consumption would have been without those measures in place. Net savings are defined as the difference in energy consumption with the program in place versus what consumption would have been without the influence of the subject program (Violette and Rathbun 2017). While the definition of net savings varies somewhat across states, this term generally reflects the fact that energy savings from actions taken by participants may not be due specifically to the program itself. See Billingsley et al. (2014) for a more in-depth discussion of our rationale for utilizing gross savings estimates.

24 Data reported by some POU program administrators included evaluated savings. However, the majority of the reported data were not validated by independent third-party evaluators.

25 Because we apply a discount rate to calculate levelized values, savings in later years have less impact on the PA CSE.

Table 2-2. Savings-weighted measure lifetimes by market sector used to levelize program costs

Market Sector	Savings-Weighted Measure Lifetime (years) Assumed in PA CSE Analyses
C&I	12.7
Residential	7.7
Low Income	12.5
Cross Cutting/Cross Sector	14.7
Portfolio	11.8

C&I – commercial and industrial; PA CSE – program administrator cost of saving electricity

The focus of our analysis is on savings-weighted average and median CSE values. The savings-weighted averages are calculated using costs and savings for all programs over the average lifetime of savings at each level of analysis (i.e., portfolio and market sector). These values include all spending, including spending on programs for which no savings are claimed (e.g., portfolio support programs). Because the averages are weighted by savings, larger programs have greater influence on average PA CSE than smaller programs. We also report medians and ranges in CSE values for each market sector by calculating and depicting interquartile ranges—the middle 50 percent of values (i.e., from the 25th to 75th percentile).[26] These metrics are drawn from a slightly smaller subset of data because the calculation requires that each sector-year data point have both spending and savings values.

2.3 Program Data Quality, Consistency, and Availability: Issue and Challenges

Certain data and reporting issues can adversely impact data quality and may confound analysis and compromise the integrity of results. These issues include incomplete or inconsistent data reporting and difficulties in defining and reporting annual and lifetime savings of efficiency measures. Prior Berkeley Lab publications provide a detailed explanation of those issues and our approach to addressing them (Hoffman et al. 2013; Billingsley et al. 2014; Hoffman et al. 2015; Hoffman et al. 2018).

We developed procedures for standardizing data across states to address and mitigate these issues. For example, when a program administrator reported only net savings, we sought program-level net-to-gross ratios for the same program in the same year—or, as second best, in a contiguous year—in order to convert the values to gross savings. Fortunately, program administrators often reported both net and gross savings or supplied net-to-gross ratios that enabled the conversion. Also, as described above, where average measure lifetimes were not available for a program, we imputed values using an average value for similar programs, as reported by POU program administrators. Program administrators also provided average measure lifetimes for about two-thirds of our dataset.[27]

[26] All values for a given program, market sector, or administrator in a state are included in determining savings-weighted averages, including programs for which savings are not reported. Median PA CSE and interquartile ranges require calculation of the PA CSE at each level, for each sector year, so each data point must have reported savings.

[27] POU program administrators reported average measure lifetimes or lifetime savings, from which the measure lifetime can be derived, for about two-thirds of the data we collected for this study. By comparison, IOUs reported information on these values for 40 percent of the IOU data in our database.

Some POU program administrators engaged professional evaluators to study their programs and measure installations to develop these values. More often, POU program administrators indicated that they lack resources for funding the kind of detailed evaluations of their programs that would generate program-specific values for annual savings and savings lifetimes for efficiency measures. In the absence of data specific to their programs and current markets conditions, POU program administrators indicated that they, like administrators of IOU customer-funded programs, sometimes look to the program evaluations or measure savings assumptions of neighboring utilities.

Like IOUs, POUs sometimes use round estimates for savings lifetimes. In our POU dataset, for about 35 percent of the data where information on measure lifetimes was reported or could be derived, the values were a multiple of five (i.e., exactly 5 years, 10 years, or 20 years). In rarer cases, program administrators used a single lifetime value (e.g., 14 years) for all programs in a given sector, regardless of whether the promoted measures were efficient light bulbs or heat pumps.

Practices also vary among administrators in defining the baseline energy usage for estimating savings—that is, energy use expected in the absence of the energy-saving measure or activity. Some program administrators may use existing building energy codes or end-use and equipment standards as a baseline, while others may use the efficiency of the replaced equipment (CEE 2018), which tends to produce higher savings estimates and thus a lower cost of savings. Explicit identification of baselines tends to be more frequently documented for IOU customer-funded programs than for POU programs.

With respect to Berkeley Lab's internal data management, we applied internal quality assurance (QA) protocols. Data collection tools included flags for apparent extreme or outlying values.[28] Once a researcher completed data entry for a state, a second researcher did extensive spot-checking based on a specified protocol. Based on these protocols, more than half of the collected data were verified against the original reported values. Our data entry and QA processes also helped identify issues that we resolved internally or discussed with program administrators or, in a few cases, state staff.

[28] We applied a test for potential outliers at two standard deviations from the mean. We were unable to find satisfactory explanations for the most extreme of these values, and we dropped nine (less than 0.3 percent) from the analysis.

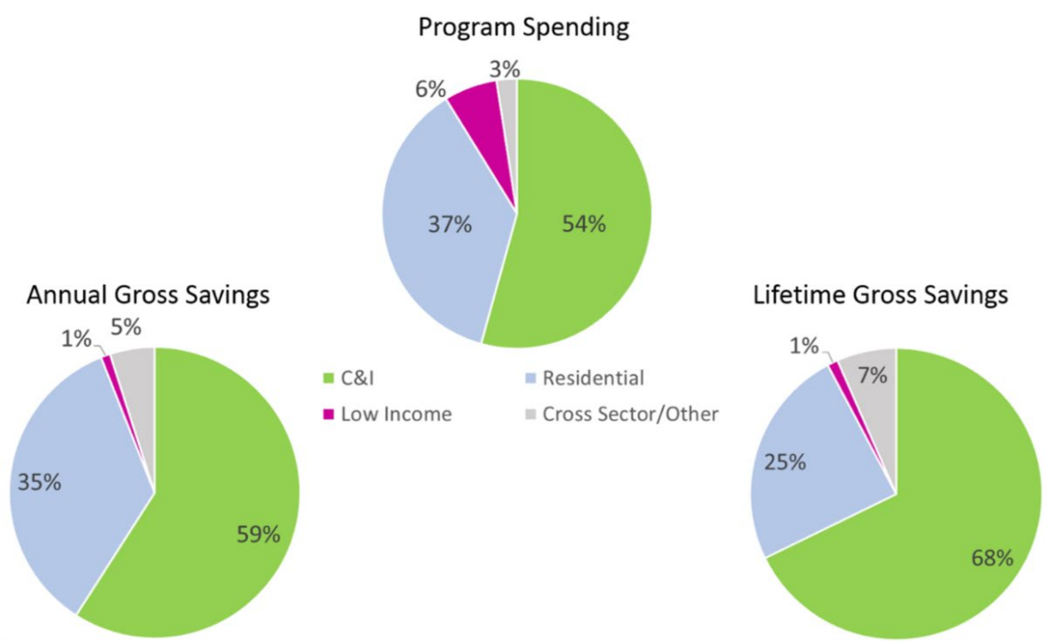
3. Reported Spending and Savings by Market Sector: 2012–2017

This chapter provides an overview of spending and gross savings for POU electricity efficiency programs in our dataset during the period 2012 to 2017.

Our dataset includes $2.4 billion (2017$)[29] in reported spending on electricity efficiency programs funded by POU customers during the study period. This level of program spending represents about 1.9 percent of revenues for those POUs, ranging from a low of 1.7 percent in 2012 to a high of slightly more than 2 percent in 2017.[30] As Figure 3-1 shows, the C&I sector accounts for 54 percent of that spending total, while programs that target residential customers and low-income customers account for 37 percent and 6 percent, respectively. The figure also shows the market sector breakdowns for both annual and lifetime gross savings.

The distribution of spending and savings among the residential and low-income sectors should be considered in the context of an unknown amount of low-income activities that are included in the residential sector data (see text box in this section). For context, bundled retail sales for residential customers accounted for about 37 percent of total sales in 2017 for POUs.[31]

Figure 3-1. Reported spending and annual and lifetime gross savings by market sector for 111 POU program administrators: 2012–2017



[29] Note that earlier figures in this report on spending are in nominal dollars and thus lower.
[30] For some municipal associations or other aggregators serving as program administrators for multiple POUs, the identification of the POUs served sometimes was not clear (e.g., an unspecified subset of a municipal association's members) or changed from year to year (e.g., some POUs for which an aggregator had served as program administrator decided at some point to administer their own programs). In these cases, Berkeley Lab applied its best judgment, based on the information available. In all cases, however, the uncertainty involved smaller POUs, with modest program spending, savings, and loads relative to our dataset, and thus has limited impact on these estimates.
[31] Calculated using EIA Tables 6 and 10, from forms EIA 861 and 861S, https://www.eia.gov/electricity/data.php.

The 111 program administrators in our dataset reported 11,329 gigawatt-hours (GWh) of annual savings for the six-year period. These savings represent about 1.2 percent of retail sales for the POUs that we could match to the POU program administrators in the dataset over our study period, ranging from about 1.1 percent of sales in 2012 to 1.3 percent in 2017. The C&I sector accounted for 59 percent of annual gross savings, the residential sector accounted for 35 percent, and the low-income sector accounted for 1 percent. The contribution of the C&I sector is more pronounced for lifetime savings, a more relevant metric for resource value. As Table 3-1 shows, C&I programs provided 68 percent of estimated lifetime savings, while residential and low-income programs accounted for 25 percent and 1 percent, respectively.

Table 3-1. Program spending and savings reported by 111 POU program administrators, by market sector: 2012–2017

Market Sector	Share of Program Administrator Spending (%)	Program Administrator Spending (Billions 2017$)	Share of Annual Gross Savings (%)	Annual Gross Savings (GWh)	Share of Lifetime Gross Savings (%)	Lifetime Gross Savings (GWh)
C&I	54	1.3	59	6,694	68	84,856
Residential	37	0.9	35	3,954	25	30,624
Low Income	6	0.2	1	118	1	1,479
Cross Sector/Other	2	0.1	5	563	7	8,248
Total		**2.4***		**11,329**		**124,500**

*Because this table uses constant 2017 dollars, total spending is adjusted for inflation and thus is higher than the nominal value in Table 2-1.

POU – Publicly owned utility; GWh – gigawatt-hour; C&I – commercial and industrial

Program administrators, in aggregate, devoted roughly similar shares of their spending to low-income programs as did administrators of programs funded by IOU customers (about 6 percent). Those programs achieve a similar share of lifetime savings for the overall portfolio—1 percent for POUs and 2 percent for IOUs (Hoffman et al. 2018). Programs in our POU dataset are concentrated in California, the Pacific Northwest, and Minnesota, which are generally areas with explicit state policies that strongly emphasize energy efficiency programs for low-income households.[32]

Cross-sector programs can contribute a meaningful share of savings. The largest source of those savings in our POU dataset are programs that support the adoption and enforcement of building energy codes in the residential and commercial sectors—e.g., education and training.

[32] For more information, see ACEEE's State and Local Policy Database: database.aceee.org/state/guidelines-low-income-programs.

Low-Income Programs—Allocating Costs and Savings

Allocating program administrator costs and savings in the low-income sector was challenging for this study. Until 2016–2017, few POU program administrators in our sample reported the amount of spending in this sector, yet some indicated that low-income efficiency activities were included in their residential portfolios. For example, in 2017 only a third of the POU program administrators in our dataset indicated that they offered low-income programs. By contrast, about three-quarters of IOU program administrators report low-income programs in recent years (Hoffman et al. 2018). States often require IOUs to offer separate low-income efficiency programs and sometimes specify minimum levels of spending. These requirements help ensure that opportunities for energy savings are equitably distributed.

Many POUs are motivated by similar interests. For example, the Los Angeles Department of Water and Power has metrics for energy-saving opportunities across customer classes, including low-income customers. In states with policies that explicitly support energy efficiency programs for low-income households and apply those policies to POUs, POU program administrators typically report those programs separately. Reporting elsewhere often is subsumed within residential program offerings that are not explicitly income-qualified. Common examples are more intensive targeting of retrofit programs in neighborhoods with a substantial number of low-income households or offering program designs more likely to appeal to low- and moderate-income customers (e.g., a pre-pay program that provides real-time feedback to residential customers on their usage and charges that is not income-qualified, but appeals mostly to low- and moderate-income customers).

Many POU efficiency programs target hard-to-reach customers, including low-income households, even though such efforts may not be reported discretely. A recent APPA survey with 71 utilities responding found that 80 percent targeted efficiency programs to disadvantaged customers and 63 percent specifically targeted efficiency programs to areas with low-income residents.*

In addition, some POUs do not separately report low-income customer participation in programs unless the program is only open to low-income households. The result may be significantly underestimating the electricity that efficiency programs save in the low-income sector.

Further, programs for low-income customers tend to cost the administrator more, in part because the program typically pays a higher share, or all, of the cost of the efficiency measures (see Section 4.1). In addition, costs for low-income programs often are comingled with other city actions. For example, POUs may install smoke detectors and carbon dioxide monitors on behalf of the fire department, and to support workforce development may use student crews to install low-flow showerheads, caulking and weather-stripping, smart thermostats, and other devices. Thus, including low-income efficiency initiatives within the residential sector programs category could elevate the PA CSE for the residential sector and make cost comparisons between the residential and C&I market sectors more ambiguous.

* Smart Energy Provider program survey by APPA; communication with Alex Hoffman, May 28, 2019.

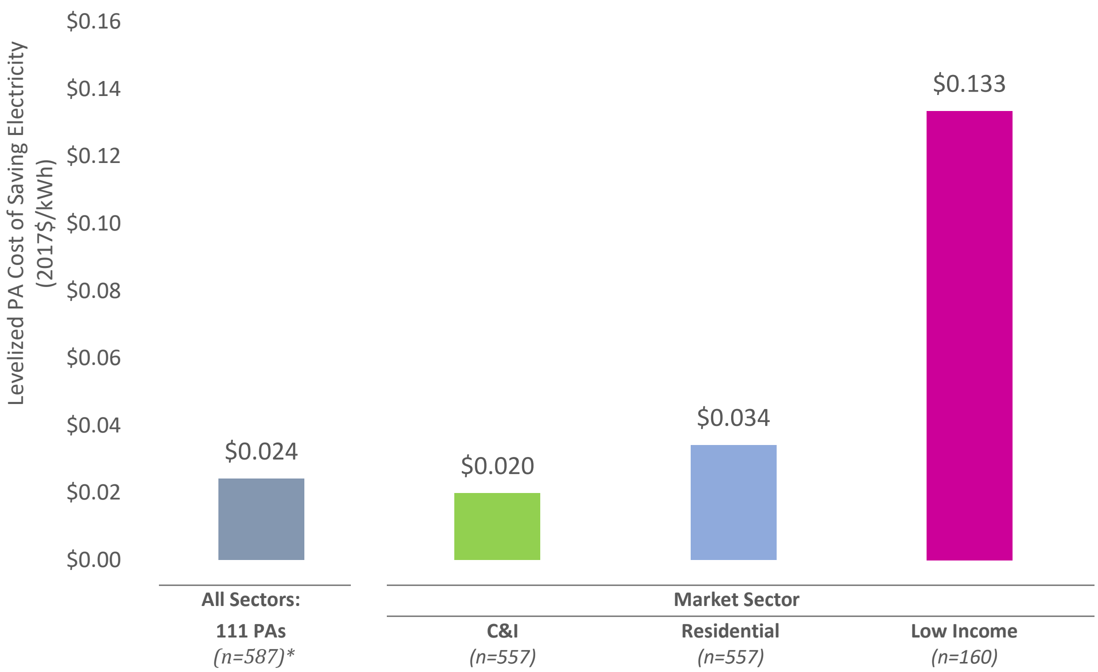
4. Results: Program Administrator CSE for Publicly Owned Utilities

This chapter presents estimates of the savings-weighted average PA CSE for 111 POU program administrators operating in 14 states, based on reported data. We first present results in aggregate, then by region and market sector. These breakdowns include medians and the middle interquartile range of CSE values (25th to 75th percentile) to provide both the central tendency and variability across our program sample. We also discuss trends in PA CSE over time (2012 to 2017). Unless otherwise noted, PA CSE values, figures and tables depict levelized, savings-weighted values.

4.1 National Results

The PA CSE for the full portfolio of programs offered by the 111 POU program administrators in our dataset for the 2012–2017 period is \$0.024/kWh, in constant 2017 dollars (see Figure 4-1). This value is sensitive to a number of assumptions, such as the assumed measure lifetimes and discount rate.[33]

Figure 4-1. Savings-weighted PA CSE for electricity efficiency programs by market sector for 111 POU program administrators: 2012–2017[34]



** Includes cross-sector activities for which savings are sometimes not claimed, but which support efficiency activities (e.g., planning, research, market assessments, evaluation, and measurement).*

PA – program administrator; CSE – cost of saving electricity; kWh – kilowatt-hour; C&I – commercial and industrial; n – sample size

[33] For example, applying the 6 percent cost of capital value we use in cost of saving electricity studies for IOUs, instead of the 4 percent applied for this POU study (capital costs for POUs are lower; see Chapter 2), increases PA CSE about 11 percent to \$0.027/kWh. Applying a 2 percent cost of capital value decreases PA CSE to \$0.021/kWh.

[34] Throughout this report, sample size (n) is in portfolio years for the full dataset of 111 POUs and for regional analyses, and in sector years for market sector results.

For the POU programs in our dataset, the C&I sector supplied the lowest-cost electricity savings at $0.020/kWh, on average, for 2012–2017. The average PA CSE for POU residential programs is $0.034/kWh, about 72 percent higher than the C&I average. The average cost of savings for low-income programs is $0.133/kWh, significantly higher than other market sectors, as is the case for IOUs (Hoffman et al. 2018).

The finding that the C&I sector has the lowest cost of electricity savings for POUs differs from recent studies (e.g., Hoffman et al. 2018) that identified the residential sector as the least-cost source of electricity savings for programs funded by IOU customers. A definitive explanation is beyond the scope of this report. However, the difference *may* be the result of several factors, including the following:

- The savings-weighted average measure lifetime for the residential sector is 7.7 years,[35] roughly 40 percent lower than the average measure lifetime for the C&I sector. That discounts and spreads residential sector costs over a shorter period, resulting in a substantially higher PA CSE. The shorter lifetime was driven by relatively few but very large behavioral feedback programs with an assumed measure lifetime of one year.
- Residential lighting appears to have supplied a significantly smaller share of electricity savings for POU programs in the 2012–2017 study period, compared to IOU customer-funded programs, based on our latest IOU cost of saving electricity study (for 2009–2015). It's possible that lighting measures were not called out in the data we collected for some POU residential programs. Another possible explanation is that POUs are placing greater emphasis on programs targeting efficiency actions that customers are less likely to take on their own.
- Efficiency programs may differ significantly in the size of markets and program intervention points. The larger territories of IOUs and their collective market clout with manufacturers and national distributors and retailers may enable broader market reach, scale, and impact for certain products, such as lighting.[36]
- As Chapter 3 notes, many POUs include at least some aspects of efficiency initiatives for low-income households in their reporting of residential program costs and savings. If significant efforts to reach these households are embedded in POU residential sector programs open to other households, the residential sector PA CSE reported in this study would be somewhat higher than otherwise would be the case. These ambiguities complicate interpretation of the PA CSE in both the residential and low-income sectors—and for comparisons with the C&I sector.

[35] For comparison, the average lifetime for IOU residential programs is longer (See Table D-2, Appendix D, in Hoffman et al. 2018 for the range of values). A longer measure (or program) lifetime drives down PA CSE values. As noted here, our POU dataset includes several large programs with an assumed short measure lifetime, driving down the average lifetime for the residential sector.

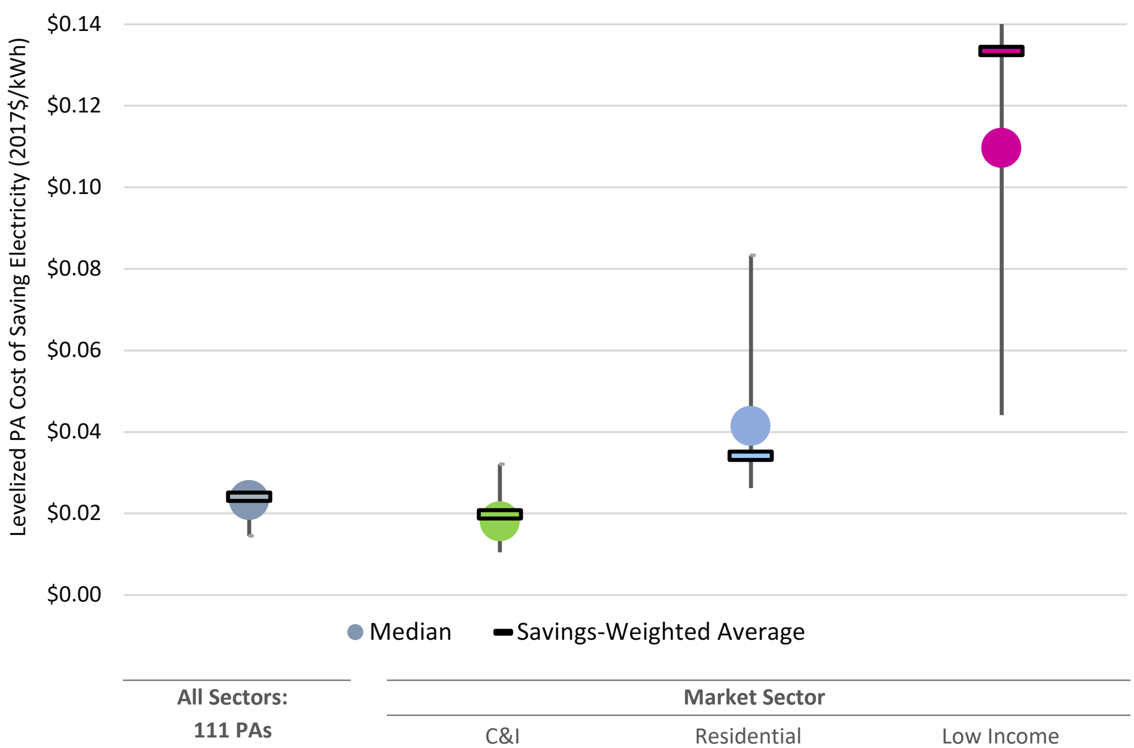
[36] Many POUs participate in regional and national initiatives to tap these benefits. For example, see members of the Northwest Energy Efficiency Alliance (https://neea.org/about-neea) and Consortium for Energy Efficiency (https://www.cee1.org/content/member-directory).

The PA CSE for low-income programs is higher than for other sectors. Program administrators typically pay the full cost of measures for these programs and often incur costs to address issues related to the poor condition of older homes and health and safety issues (e.g., asbestos removal, old wiring) before efficiency measures can be installed. Low-income programs also often have aims beyond energy savings (e.g., lower energy bills, improved health and safety of occupants, better comfort).

As a reference point, Seattle City Light reviewed these PA CSE results for consistency with the PA CSE using its own Customer Energy Solutions (CES) data. Results are similar to those reported by Berkeley Lab, with CES' residential sector aligning almost exactly at $0.034.[37]

Median and average PA CSE values are nearly identical for the C&I sector and fairly close for the residential sector (see Figure 4-2). That indicates that cost performance of POU program administrators with midsize portfolios is close to that of the program administrators with larger portfolios that most influence the savings-weighted sector averages. It is possible, for example, that larger, more common C&I programs deliver similar cost performance regardless of scale. In the residential sector, the median PA CSE value is higher than the savings-weighted average, possibly indicating that larger scale may have a larger influence on cost performance for at least a subset of programs.

Figure 4-2. PA CSE medians and interquartile ranges for 111 POU program administrators, by market sector: 2012–2017



PA – program administrator; CSE – cost of saving electricity; kWh – kilowatt-hour; C&I – commercial and industrial

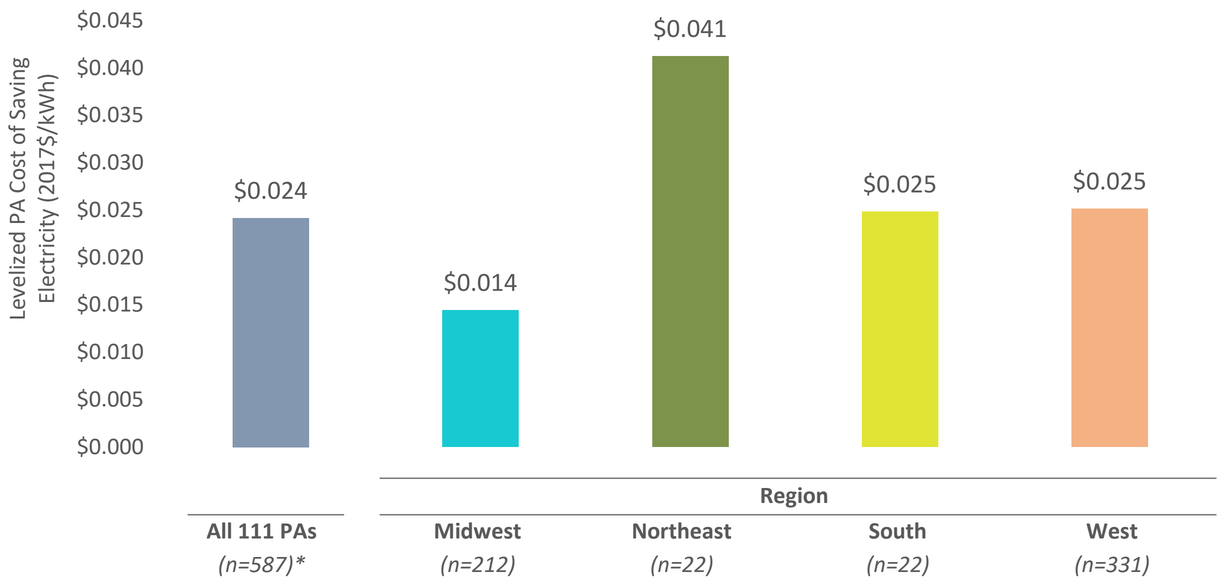
[37] Brenda Simon, Seattle City Light, commenting on a draft version of this Berkeley Lab report, May 22, 2019.

The overall pattern of variability is consistent with Berkeley Lab's studies of the cost of saving electricity for IOU customer-funded programs: While we do not report program-level results in this initial study on the cost of saving electricity for POUs, the data that we reviewed indicate that C&I programs tend to have less variability in cost performance than residential programs. Cost performance for low-income programs for both POUs and IOUs tends to vary widely, perhaps due in part to diversity in program designs and measure mix, from swapping out lightbulbs and appliances to full retrofits and heating or air-conditioning system replacements.

4.2 Regional Results

The savings-weighted PA CSE varied among U.S. Census regions, ranging from a low of $0.014/kWh in the Midwest to $0.041/kWh in the Northeast (Figure 4-3), a nearly three-fold difference. The West and South PA CSE values are close to the national average in part because, with 88 percent of the savings in the dataset, they largely define the national average.

Figure 4-3. Savings-weighted average PA CSE by U.S. Census region for 111 POU program administrators: 2012–2017



** Includes cross-sector activities for which savings are sometimes not claimed, but which support efficiency activities (e.g., planning, research, market assessments, evaluation, and measurement).*

PA – program administrator; CSE – cost of saving electricity; kWh – kilowatt-hour; n – sample size

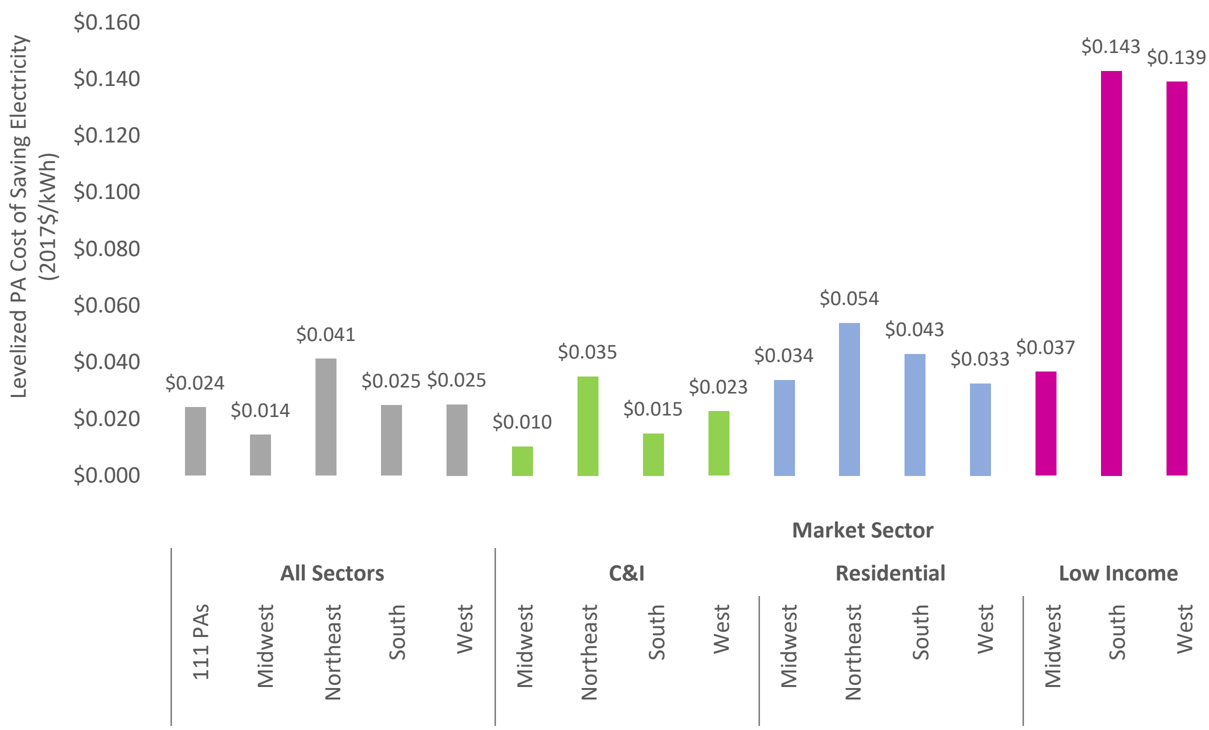
The average portfolio PA CSE among Midwest program administrators in our dataset ($0.014/kWh) is 39 percent lower than the national average. POU program administrators in the region appear to be taking advantage of low-cost savings in the C&I sector, particularly industrial and agricultural projects that tend to be low cost. Nearly 80 percent of Midwest programs with the lowest cost of electricity savings (<$0.014/kWh) targeted C&I markets.

Northeast POU programs in our sample have a significantly higher PA CSE, on average, than other regions, though the sample includes only four program administrators, all in states with longstanding efficiency initiatives. The POU sample size is also small in the South, but program administrators are far larger and working in markets with significant low-cost savings in the C&I sector, as in the Midwest.

The PA CSE values for the West are heavily influenced by large POUs in California, Arizona, and the Pacific Northwest, including several of the nation's largest POUs. Sizable electricity savings from these programs, particularly in the C&I sector, have a strong influence over the savings-weighted average PA CSE for the 111 PAs in our study. Sector-level values for each region (Figure 4-3) offer more evidence that the C&I sector provided the lowest cost savings.

Figure 4-4 illustrates the variability in PA CSE by sector and region. Consistent with our research on the cost of saving electricity for IOUs, programs that target customers in the low-income and residential market sectors have the most variability, likely reflecting diversity in program designs and performance. The dependability of C&I markets for low-cost savings for POUs suggests one reason for the level of investment there compared to other sectors. Program-level research would better reveal the potential of continued low-cost C&I savings for POUs.

Figure 4-4. Savings-weighted PA CSE by market sector and U.S. Census region for 111 POU program administrators: 2012–2017[38]



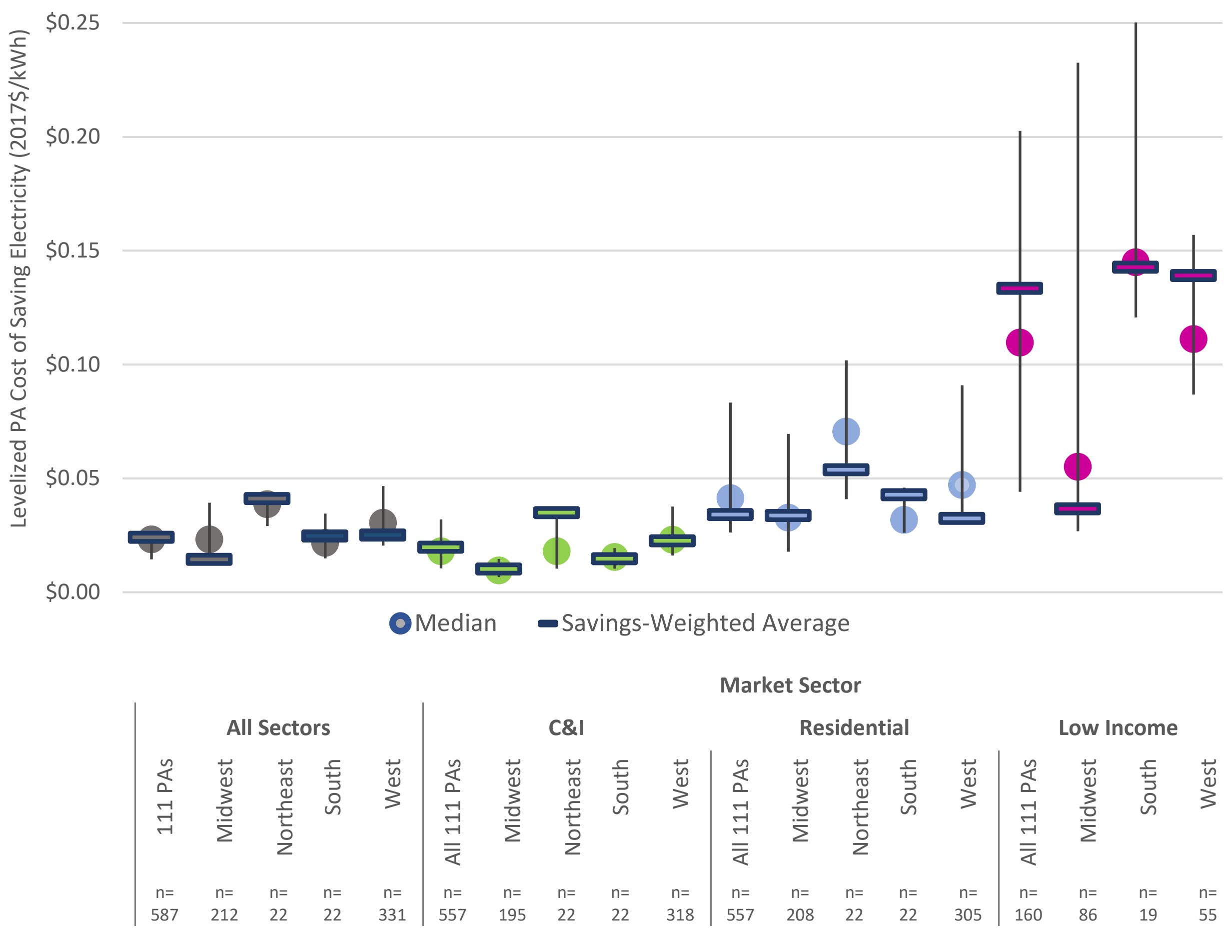
PA – program administrator; CSE – cost of saving electricity; kWh – kilowatt-hour; C&I – commercial and industrial

[38] We do not report low-income sector results for the Northeast because of insufficient data in our collection.

As noted in Chapter 3, some caution is warranted in the distinction between residential and low-income programs. We exercised care in characterizing programs in these sectors, but some uncertainty remains with respect to how much low-income savings are embedded within residential offerings for some POU program administrators. The higher PA CSE values for POU low-income programs in the West and South are roughly in line with the values for IOU programs. The lower value in the Midwest may be a result of POU program administrators there paying less of the total measure costs, but it was outside the scope of this study to determine the reasons for their lower reported program costs.

Figure 4-5 and Table 4-1 further illustrate the variability of PA CSE values. Savings-weighted PA CSE values that are lower than median values, as in the residential sector in the Northeast and West, may indicate that larger and more experienced program administrators are better able to manage costs and achieve some economies of scale. In the C&I sector, however, median and savings-weighted averages for the PA CSE are nearly the same in all regions. That suggests that C&I savings are reliably low or moderate in cost regardless of the size of the POU program administrator. This is another area where program-level research could provide valuable insights into the factors that influence program costs.

Figure 4-5. PA CSE medians and interquartile ranges by sector and U.S. Census region for 111 POU program administrators: 2012–2017



PA – program administrator; CSE – cost of saving electricity; kWh – kilowatt-hour; C&I – commercial and industrial

Table 4-1. PA CSE medians and interquartile ranges by market sector and U.S. Census region for 111 POU program administrators: 2012–2017

	Sample	Region	1st Quartile ($)	Median ($)	3rd Quartile ($)	Savings-Weighted Average ($)
All Sectors	n=587	All 111 PAs	0.014	0.023	0.014	0.024
	n=212	Midwest	0.014	0.023	0.039	0.014
	n=22	Northeast	0.029	0.039	0.044	0.041
	n=22	South	0.015	0.022	0.035	0.025
	n=331	West	0.020	0.030	0.047	0.025
Commercial and Industrial	n=557	All 111 PAs	0.010	0.018	0.032	0.020
	n=195	Midwest	0.007	0.010	0.015	0.010
	n=22	Northeast	0.010	0.018	0.032	0.035
	n=22	South	0.010	0.015	0.019	0.015
	n=318	West	0.016	0.023	0.038	0.023
Residential	n=557	All 111 PAs	0.026	0.041	0.083	0.034
	n=208	Midwest	0.018	0.033	0.070	0.034
	n=22	Northeast	0.041	0.071	0.102	0.054
	n=22	South	0.026	0.032	0.046	0.043
	n=305	West	0.030	0.047	0.091	0.033
Low Income[39]	n=160	All 111 PAs	0.044	0.110	0.203	0.133
	n=86	Midwest	0.027	0.055	0.233	0.037
	n=19	South	0.121	0.145	0.339	0.143
	n=55	West	0.087	0.111	0.157	0.139

PA – program administrator; CSE – cost of saving electricity; POU – publicly owned utility

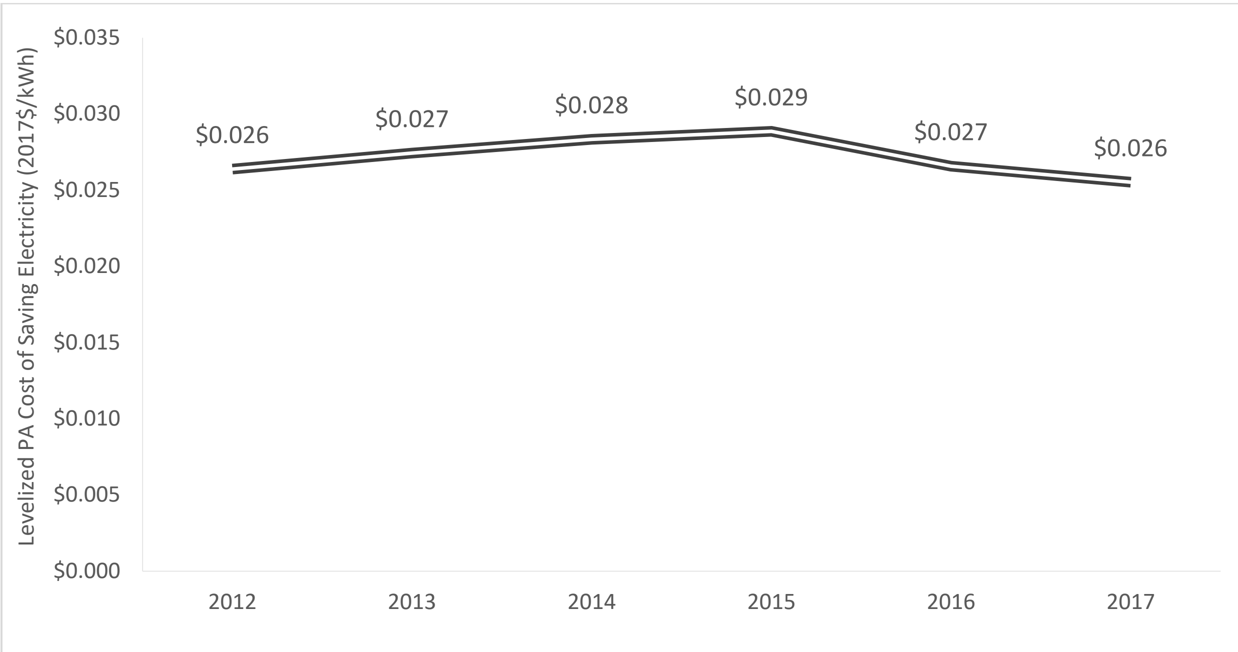
4.3 Trends in the Program Administrator Cost of Saving Electricity

We also examined trends in the cost of saving electricity. Some 79 of the 111 program administrators in our sample provided continuous portfolio-level data[40] over the six-year study period.[41] We focused on this balanced panel of 79 program administrators to exclude the potential impact of (1) program administrators with incomplete time series that pass in and out of the dataset and (2) new program administrators ramping up their efficiency programs in recent years, thus more likely to reflect the expenses of building program infrastructure and trade relationships rather than the costs of acquiring electricity savings.

[39] We do not report low-income sector results for the Northeast because of insufficient data in our collection.
[40] In one case, we assembled a continuous series of data from two incomplete series. In another case, a municipal utility began administering programs on its own, instead of through an association, about halfway through the study period. We recombined these three incomplete data series into a single continuous data series for this analysis alone.
[41] For this time series analysis, continuity is measured by spending and savings data at the portfolio level for each year of the 2012–2017 period. That continuity did not extend to the sector level in all cases—e.g., all 79 program administrators did not offer low-income programs in all years of the study period.

Figure 4-6 illustrates changes in the estimated average PA CSE among POU efficiency program administrators with continuous data.

Figure 4-6. Estimated savings-weighted average PA CSE for all programs offered by 79 POU program administrators with continuous data: 2012–2017



PA – program administrator; CSE – cost of saving electricity; POU – publicly owned utility; kWh – kilowatt-hour

On average, across all programs reported by the 79 program administrators, the estimated PA CSE varied only modestly in the 2012–2017 period and ended up slightly lower in 2017 than in 2012, with a compound average growth rate of -0.7 percent.[42] This slight decrease in PA CSE occurred even as spending relative to POU revenues increased at a slightly faster rate during this period, from 1.7 percent of revenues in 2012 to 2 percent of revenues in 2017.

This finding varies somewhat from recent findings of a modest uptick in the cost of electricity savings for IOU customer-funded programs (Hoffman et al. 2015, 2018). Future research could better characterize trends at the sector and program levels and yield insight into where POU program administrators may look for least-cost savings in the future.

The year-by-year averages in Figure 4-6 are higher than the averages for all 111 program administrators. That's because the 79 program administrators account for 90 percent of the spending in the full dataset, compared to 74 percent of the savings. In general, most of these program administrators serve states and medium to large cities with generally higher labor costs, as compared to rural areas. In addition, the majority of electricity savings in our dataset are from utilities that serve large cities.

[42] Rounding in the chart obscures this slight decline.

5. Summary, Progress and Challenges, and Future Research Areas

5.1 Summary

This study is by far the most expansive effort to date to assess the average cost of saving electricity for POUs. The data represent 88 percent of all POU spending and 75 percent of all POU savings for electricity efficiency programs during our study period, as reported to the EIA. Our dataset is unevenly distributed among the states, however, with the West and the South accounting for 88 percent of the program spending. Thus, some caution is warranted in characterizing the values in this report as the definitive cost of electricity savings for U.S. POU efficiency programs, at least in the Midwest and Northeast. An additional source of caution is our reliance on *utility- or program administrator-reported* data as the basis for the results, as with our analyses of IOU customer-funded programs.

Based on data reported by 111 POU efficiency program administrators in 14 states, covering 219 POUs, we estimate the savings-weighted average PA CSE at $0.024/kWh (2017$) for the period 2012–2017. The C&I sector provides the largest and least-cost supply of POU savings. This finding contrasts with our studies of IOU customer-funded programs that have consistently identified the residential sector as the lowest-cost source of efficiency. Reasons for the divergence may include differences in savings-weighted average measure lifetime for the residential sector and embedding some low-income efficiency activities within the residential sector.

The PA CSE varies by region, with a wide difference between the Midwest average of $0.014/kWh and Northeast average of $0.041/kWh. Average values in the South and West are on par with one another. Because the South and West account for 88 percent of savings in our dataset, these regions largely define the overall savings-weighted average PA CSE for all 111 POU program administrators in our sample.

Based on 79 POU program administrators with continuous portfolio-level data across the study period, the 2012–2017 trend in the average PA CSE was flat, while the relative magnitude of savings increased (1.1 percent of retail sales in 2012 to 1.3 percent in 2017). These findings suggest that POU program administrators, on average, have managed to reach moderately high savings levels while containing costs.

Federal and state energy-performance standards are expected to have somewhat greater future influence on residential programs administered by utilities, by shifting savings acquisition to standards and transforming markets for certain common residential end uses such as lighting. The C&I sector, on the other hand, is relatively less impacted than the residential sector by near-term standards and may remain a lower cost source for utility efficiency programs, at least in the near to mid term.[43] Given the relatively high percentage of C&I savings in our sample of POU efficiency programs, this bodes well for

[43] All else being equal, as more rigorous energy standards reduce energy consumption and demand, the potential and actual electricity savings from efficiency programs trends lower because of more efficient baseline assumptions. See Hoffman et al. 2018.

maintaining low overall costs for efficiency in POU resource portfolios and the continued viability of efficiency for reducing load growth and keeping down utility system and customer costs.

5.2 Progress and Challenges: Program Data Collection and Reporting

A significant number of POU efficiency program administrators offer evaluated savings and reporting on par with, and sometimes more comprehensive than, reporting for IOU customer-funded programs. However, our collection, validation, and standardization of program spending and savings data indicate that POU program administrators have many of the same challenges in estimating and reporting savings that IOU program administrators experience. In particular, many POUs do not provide a complete picture of the impacts or costs of efficiency investments at the program level. While the utility's reporting may be adequate for local oversight, opportunities for program innovation and streamlining may be missed without the ability to compare program-level activities with other POUs (and IOUs and rural electric cooperatives).

Improvements in consistency, completeness, and transparency of program-level reporting can help reveal these opportunities. A program reporting tool that Berkeley Lab developed with APPA is one place to start.[44]

One specific area for improvement across all types of utilities is determining program average measure lifetimes—essential for estimating lifetime savings and calculating PA CSE—for use in benchmarking efficiency programs and resource planning. The tendency among some program administrators is to use round numbers and borrow values from other jurisdictions. Improving the rigor of program average measure lifetimes would give utilities greater confidence in persistence of electricity savings, efficiency impacts considered in load forecasts, and continued investments in efficiency to keep electricity costs affordable. Other areas for improvement, particularly for POUs, are consistent application of net and gross savings definitions and calculation assumptions and methods, standardization of reporting electricity savings with and without transmission and distribution losses (i.e., source versus site savings), and use of a consistent typology of program definitions.[45] State or regional technical reference manuals can help.[46]

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[44] See Hoffman et al. 2016.
[45] See Appendix B and https://emp.lbl.gov/publications/energy-efficiency-program-typology.
[46] See Schiller et al. 2017. Also see Ehrendreich et al., *Evaluating the Need for a Regional Energy Efficiency Technical Resource Manual for Small Utilities in the Midwest*, prepared for the Midwest Energy Efficiency Alliance, April 2019, http://www.mwalliance.org/sites/default/files/meea-research/small-utility-trm-paper_final.pdf.

5.3 Future Research Areas

This study highlights several potential future areas of research that could advance understanding of the role of electricity efficiency to achieve POU objectives, including minimizing both system and customer costs:

- Collecting and analyzing data from additional POUs, particularly in regions where data collected for this initial study are sparse (South and Northeast), for larger sample size and more diversity
- Program-level analysis of cost performance for the most prevalent POU program types
- Trends in cost performance by market sector and for select programs on which POU program administrators most rely for electricity savings
- Total cost of saving electricity for POU programs, including participant costs
- Cost performance for large versus small POU program administrators, for a range of program types, to assess the potential for scaling programs and savings cost-effectively
- Energy efficiency program models for smaller POUs
- Detailed characterization of residential sector programs to improve understanding of costs attributable to programs targeting low-income households
- Ways to increase POUs' use of the energy efficiency program reporting tool that Berkeley Lab developed with APPA

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Appendix A. Study Dataset

Table A-1. Number of POU program administrators in the dataset, by state

State	Number of Program Administrators
AZ	1
CA	37
CO	1
CT	2
FL	2
ID	1
MA	1
MI	2
MN	37
NE	3
OR	5
TX	2
VT	1
WA	16
TOTAL	**111**

Table A-2. List of POU program administrators in the dataset

Adrian Public Utilities (MN)
City of Aitkin (MN)
Alameda Municipal Power (CA)
City of Anaheim (CA)
Anoka Municipal Utility (MN)
Austin Energy (TX)
Azusa Light and Water (CA)
City of Banning (CA)
Benton County Public Utility District #1 (WA)
City of Biggs (CA)
Biwabik Public Utilities (MN)
Brainerd Public Utilities (MN)
Brewster Light & Power (MN)
Burbank Water and Power (CA)
Burlington Electric Department (VT)
Central Minnesota Municipal Power Agency (MN)*
City of Chaska (MN)
Chicopee Electric Light (MA)
CPS Energy (City of San Antonio, TX)
Clallam County Public Utility District #1 (WA)
Clark County Public Utility District #1 (WA)
Connecticut Municipal Electric Energy Cooperative (CT)*
Colton Public Utilities (CA)
Columbia River People's Utility District (OR)
City of Corona (CA)
Cowlitz County Public Utility District #1 (WA)
Delano Municipal Utilities (MN)
City of Ely (MN)
Emerald People's Utility District (OR)
Franklin County Public Utility District #1 (WA)
Gilbert Water and Light (MN)
Glencoe Light and Power (MN)
Glendale Water and Power (CA)
Grand Rapids Public Utilities (MN)
Grays Harbor County Public Utility District #1 (WA)
Gridley Electric Utility (CA)
City of Healdsburg (CA)
Hercules (CA)
Hibbing Public Utilities (MN)
Holland Board of Public Works (MI)

Hutchinson Public Utilities Commission (MN)
Idaho Falls Power (ID)
Imperial Irrigation District (CA)
Inland Power & Light (WA)
JEA (Jacksonville/Northeast FL)
Los Angeles Department of Water and Power (CA)
Lake Crystal Utilities (MN)
Lansing Board of Water & Light (MI)
Lassen Municipal Utility District (CA)
Lewis County Public Utility District #1 (WA)
Lincoln Electric System (NE)
Lodi Electric Utility (CA)
City of Lompoc (CA)
Madelia Municipal Light and Power (MN)
Mason County Public Utility District #1 (WA)
Mason County Public Utility District #3 (WA)
Merced Irrigation District (CA)
Minnesota Municipal Power Agency*
Missouri River Energy Services*
Modesto Irrigation District (CA)
Moreno Valley Utility (CA)
City of Mountain Iron (MN)
Nashwauk Public Utilities (MN)
Nebraska Public Power District (NE)*
City of Needles (CA)
City of New Folden (MN)
New Ulm Public Utilities (MN)
City of Nielsville (MN)
Northern Wasco People's Utility District (OR)
Omaha Public Power District (NE)*
Orlando Utilities Commission (FL)
Pacific County Public Utility District #2 (WA)
City of Palo Alto (CA)
Pasadena Water and Power (CA)
Peninsula Power & Light Inc. (WA)
City of Pierz (MN)
Pittsburg Power Company (CA)
Platte River Power Authority (CO)*
City of Port Angeles (WA)
Port of Oakland (CA)
Proctor Public Utilities (MN)
Rancho Cucamonga Municipal Utility (CA)
Randall Municipal Utilities (MN)
Redding Electric Utility (CA)
City of Riverside (CA)
Roseville Electric (CA)
City of Round Lake (MN)
Salem Electric (OR)
Salt River Project (AZ)
San Francisco Public Utilities Commission (CA)
Seattle City Light (WA)
Shakopee Public Utilities (MN)
City of Shasta Lake (CA)
Silicon Valley Power (CA)
Sacramento Municipal Utility District (CA)
Snohomish County Public Utility District #1 (WA)
Southern Minnesota Municipal Power Agency (MN)*
Tacoma Power (WA)
The Triad (MN)*
Tillamook People's Utility District (OR)
Trinity Public Utility District (CA)
Truckee Donner Public Utility District (CA)
Truman Public Utilities (MN)
Turlock Irrigation District (CA)
City of Two Harbors (MN)
City of Ukiah (CA)
City of Vernon (CA)
City of Virginia (MN)
Wallingford Electric Division (CT)
City of Warroad (MN)
Willmar Municipal Utilities (MN)

** Serves multiple utilities*

Appendix B. Program Typology

To standardize and aggregate data at various levels, Berkeley Lab developed a standard typology that characterizes programs along several dimensions: market sector, technologies, delivery approach, and intervention strategy (Hoffman et al. 2013).[47] While our analysis for this study is at the market-sector level, rather than the specific program level, we characterized every program included in our dataset for this study in order to capture program diversity—in particular, to help define the lifetime of program savings, a key variable in the calculation of the levelized PA CSE.

We then aggregated spending and savings and analyzed the data at the market-sector level:

- *C&I* – Efficiency activities aimed at commercial, industrial, and agricultural markets. C&I market structures, measures, and applications vary more widely than in any other sector, from improved irrigation pumps to more efficient servers in data centers to promotion of conservation behaviors among tenants of large office buildings to more efficient cooking appliances in restaurants.
- *Residential* – All programs promoting energy-saving measures and activities in any residential setting, including detached single-family homes and multifamily (e.g., duplexes, apartment buildings of all sizes) and mobile homes. Programs often provide rebates or point-of-sale discounts for the purchase and installation of specific measures, such as lighting or appliances, but also include sweeping retrofits to seal leaks of conditioned air and replace heating, ventilation, and air conditioning (HVAC) equipment and insulation. Increasingly, programs are focusing on diagnosing and changing energy consumption habits in the home.
- *Low-Income* – Efficiency measures and activities tailored to residential customers who meet specific income criteria or owners of housing for low-income households. The most common interventions are retrofits of varying scope from simple air-sealing and lighting measures to roof repairs, new insulation, and full HVAC replacement. Some programs are limited to distributing more efficient light bulbs or exchanging older refrigerators for models that use less energy.
- *Cross Cutting/Cross Sector* – With notable exceptions,[48] most of these programs do not directly save energy but provide marketing, planning, or other support for the programs that do. For this reason, we typically do not analyze the cost of savings for these programs but rather include them in calculation of the PA CSE at the portfolio level.

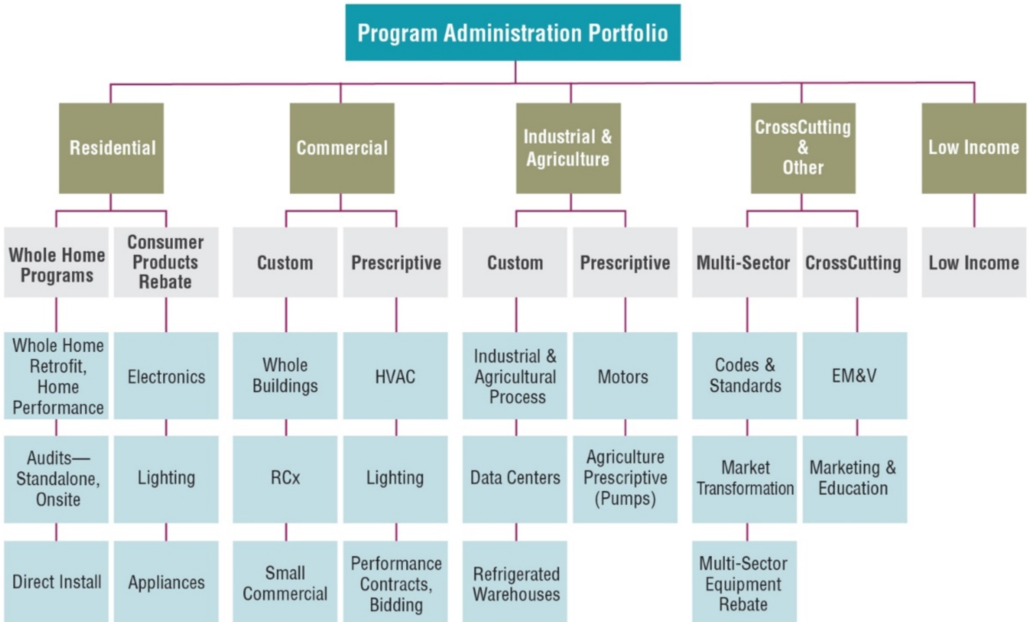
Figure B-1 provides a partial snapshot of the three tiers in the Berkeley Lab energy efficiency program typology: (1) market sector, (2) simplified program categories, and (3) detailed program categories.

[47] Berkeley Lab developed this typology in consultation with other organizations (e.g., Consortium for Energy Efficiency, ACEEE). See Appendix C of Hoffman et al. 2018 for the most up-to-date version of the typology, including definitions of the program types.

[48] A subset of cross-sector programs produces sizable energy savings at generally low cost. The most common examples are programs that report savings from supporting the adoption and enforcement of building energy codes.

In total, the typology includes seven sectors, 27 simplified program categories, and 62 detailed program categories for energy efficiency. In other Berkeley Lab studies, we compared programs in common markets (e.g., commercial custom rebate and commercial prescriptive rebate) and analyzed cost differences by program design (e.g., direct install retrofits versus home performance retrofits).

Figure B-1. Sectors and selected program types in the Berkeley Lab program typology



Note: Not all sectors and simplified and detailed program categories are shown in this figure